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SIX GENERATIONS OF *CULEX PIPIENS* WITHOUT A BLOOD MEAL

FRANKLIN C. WRAY
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About 2500 larvae and pupae of *Culex pipiens* were collected from a water filled hole in the storeroom floor of a tavern located at La Grange and Joliet Roads, Lyons Township, Illinois, on March 16, 1945. Several thousand adults were present in the room in an active condition, flying about readily when disturbed. The larvae and pupae collected were allowed to develop and emerge as adults into several lamp chimneys.

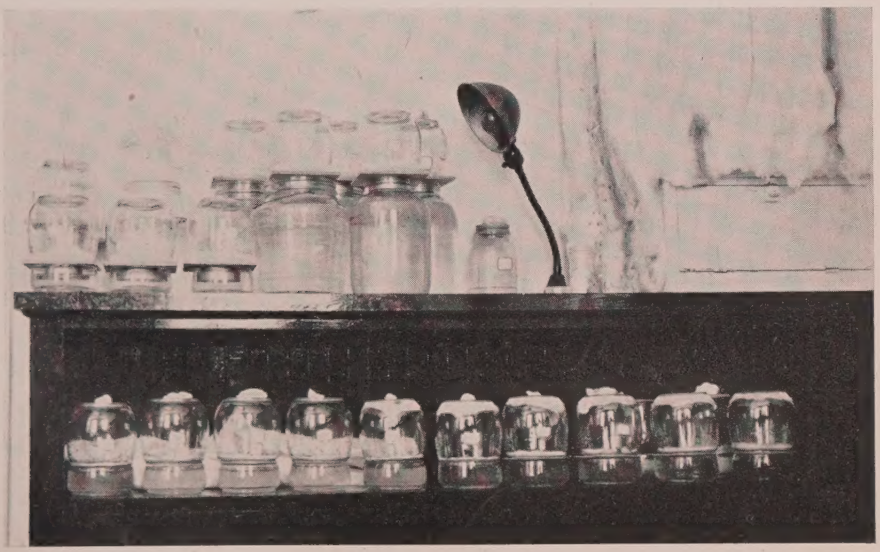
One of the chimneys containing 50 adults was placed over a bowl of water on March 29th. These adult mosquitoes were not permitted to get a blood meal from any source at any time. Five small egg rafts and about 100 larvae in the first instar were observed in the bowl on April 2nd, four days later.

This colony was kept alive for a period of 4½ months, March 29th to August 20th, passing through six generations during this time. The number of larvae, pupae and adults varied from about 1200 in the second and third generations to about 50 in the sixth and last generation.

Adults in the colony were fed by placing cotton pads saturated with a 5 per cent solution of Karo syrup on the top of the chimneys. The larvae were fed with powdered Purina Dog Chow, and occasionally a small amount of Pablum.

Oviposition occurred in from four to nine days after hatching of adults with an average time of six days. A total of 106 egg rafts were laid during the existence of the colony, none of which were normal size.

The eggs in 54 of these rafts were counted and totalled 2473, an average of 46 eggs per raft. The largest raft contained 75 eggs, and the smallest contained



Method of rearing *Culex pipiens* in bowls covered with lamp chimneys.

16 eggs. This is in contrast to normal rafts found in the field under normal breeding conditions which vary from 100 to 400 eggs.

The average number of eggs per raft in each generation ranged from 40 to 50 eggs during the first four generations, and then dropped to an estimated 20 in the fifth and no rafts in the sixth generation.

The first rafts laid were very loosely constructed, many of the eggs lying in a haphazard, irregular manner, and a few floating singly on the water surface. This condition continued from the first raft laid on April 18th, until the first week in May, when they were more normal in appearance, although a few along the edges were still laid in irregular positions. After May 10th only one out of 43 rafts was abnormal in structure.

The time required for the eggs to hatch varied from 2 to 13 days, averaging five days. The time in the larval and pupal stages averaged 15 days, ranging from 7 to 24 days. In most cases over half of this time was spent in the first and second instars.

The larvae were usually very slow in development during the first and second instars, often appearing colorless and weak, even when an excess of food was present. Their growth was usually stimulated suddenly in the third instar, without any changes being made in the type or rate of feeding.

Tap water and distilled water were both used with this colony without making any perceptible difference in the rate of development of the larvae. Although the degree of pollution of the water varied, it likewise did not affect the larvae.

During the first five generations the adults appeared much as in nature, occasionally flying about the chimneys. Placing of laboratory animals within close proximity to these adults did not agitate them, as was the case with *Aedes aegypti* when they were close to a prospective blood meal.

Those in the sixth generation rarely lived more than one or two days. For some unexplained reason they were found drowning in the water and when the bowl of water was removed, were found dead on the bottom of the chimney the following day. They did not have any inclination to lay eggs or to bite and could almost be thought to have committed suicide.

OBSERVATIONS ON THE HABITS OF *ANOPHELES FREEBORNI* IN NORTHERN UTAH AND SOUTHERN IDAHO (Diptera; Culcidae)

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AND
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Anopheles freeborni Aitken, has been discussed by Freeborn in two papers. His publication (1932) gives a detailed account of the seasonal life history of *freeborni* in the Sacramento Valley of California. The second paper (1945) gives a more comprehensive account of the ecology, distribution and seasonal life history of this mosquito. A brief discussion of the overwintering habits of *freeborni* in Utah was published by Rees (1942). The present paper concerns the seasonal behavior of *freeborni* in northern Utah and southern Idaho and is the result of a rather intensive study conducted by the junior author during the past two years, corroborated by annual notes on observations of this species made by the senior author since 1928.

It has been observed that female *freeborni* begin migrating from lower valley areas toward the warmer foothill regions of Utah and Idaho with the approach of cool, autumn weather. This so-called "prehibernation migration" usually commences when temperatures start going down during the fore part of September, and continues through October. As a result, large populations of female *freeborni* congregate in cellars, caves, barns, and similar situations along the foothill region by the fore part of November. During the summer breeding season *freeborni* are rarely encountered in shelters along the foothills especially where these shelters are three or four miles from the nearest larval habitat.

This movement of *freeborni* in the fall from the valley floor to the foothill region is apparently influenced by the mosquitoes seeking an area of higher temperature, as available shelter, food, and other factors remain more or less constant. Adult populations have reached their peak at this period; however, there is no evidence of overcrowding in the shelters occupied by *freeborni* on the valley floor.

It has been established by Alter (1941), that the foothill regions in Utah remain several degrees higher in temperature than the valley floor during the fall and winter because of the mixing effect of the air currents from the mountain slopes. According to Alter a seasonal "difference of two weeks is often noted in the same valley between bottom lands and the adjacent farm lands at the foot of the mountains." The bottom lands show a fall seasonal advance of two weeks over the foothill region.

The mosquitoes remain active in the overwintering quarters as long as temperature conditions permit. During this period of late fall they usually are to be found resting in a typical anopheline-like position upon old, dusty spiderwebs in darker corners of the quarters. While temperature conditions are favorable the *freeborni* are restless and exhibit a pronounced tendency to feed upon anyone who enters the resting places. These overwintering females appear more eager to feed upon man than do those encountered in resting places during mid-season. Their attack is stealthy and will often be repeated if they are molested and fail at first to secure a complete blood meal. Those mosquitoes in the overwintering quarters which are provoked into flight usually choose a dark, secluded spot in

which to hide. It is interesting to note that many of these will walk about over the surface of the resting place while seeking a suitable place to hide, while during the summer season *freeborni* invariably remain "fixed" when they alight after being forced to fly about in a rest shelter.

With the onset of colder weather they seek more secluded or protective hiding places beneath spiderwebs, in crevices or under loose bark, where they assume a Culicine-like posture with the body pressed closely against the resting surface. Large numbers of overwintering *freeborni* have been observed literally "packed together" beneath torn wallpaper and other protective objects.

Mortality is high among female *freeborni* which enter hibernation in northern Utah. This is particularly true of those mosquitoes in quarters with a high prevailing humidity, where sufficient moisture may condense to permit ice formation over the body of the mosquito. In situations of this type, such as in some cellars and caves, no *freeborni* was observed to survive until spring despite the rather interesting fact that they appear to manifest a predilection for the more humid situations during the prehibernation season of autumn. This conclusion is based upon comparative populations in various types of overwintering quarters during, and immediately following, the prehibernation migrations.

In less humid quarters the rate of survival among hibernating females was found to be relatively high. It was estimated that approximately five per cent of the female *freeborni* overwintering in cow barns and other dry, well-insulated places under observation during the winter of 1944 survived until spring. Males were not encountered in resting places after the middle of November in the northern Utah areas during the winter of 1944, although a few were present in favorable resting places during the first week of December in the winter of 1945.

With the advent of warmer weather in spring, generally during the fore part of April, surviving females resume activity and feed avidly upon domestic animals or men. At this time they are extremely wary so that considerable care must be exercised when making collections. They attack man in the same stealthy manner as do those encountered in the late fall.

It is believed that the female *freeborni* disperse to breading areas for the purpose of oviposition soon after securing a blood meal. At any rate populations in overwintering stations decrease sharply after the fore part of May and most resting stations in the foothills region in the northern part of Utah are devoid of *freeborni* from this time until the prehibernation migration in the fall. In shelters near larval habitats the appearance of the first spring generation of adults takes place about the second week in June, as indicated by the appearance of the first males.

Concurrent with the rapid decrease in the number of overwintering females in hibernation quarters because of the spring exodus to breeding areas, is a gradual increase in the larval population. As a general rule a few small larvae are to be found by the middle of May and larger numbers are present in breeding areas by the fore part of June. There seems to be no mid-season slump in either the larval or adult population of *freeborni* in northern Utah or southern Idaho such as occurs in the Central Valley of California as reported by Freeborn (1945), but rather a steady increase in both larval and adult numbers from the beginning of the breeding season until the cool weather of fall. The active breeding season extends from about the middle of May until the latter part of September, or October, depending upon weather conditions. The peak in adult densities generally occurs during the first part of September.

In Utah the favored *freeborni* breeding areas are pastures which are "flood irrigated" or those which are continuously watered as a result of seepage. However, larvae have been taken in nearly all types of breeding areas where the water is fresh, cool and sufficiently shaded by emergent vegetation or floatage. Flowing water is

avoided but larvae have been taken along margins of the larger irrigation canals where the water is still and partly shaded by vegetation. Larvae have not been taken in the highly alkaline waters of Utah nor in water that has been polluted as the result of cannery or creamery wastes.

Summary

The "prehibernation migration" of *Anopheles freeborni* from the valley floor to the foothill shelters in northern Utah and southern Idaho may be explained on the basis of a difference in temperature between the two regions.

During the summer season, *freeborni* remain "fixed" in an anopheline-like position after they alight, but when seeking suitable shelter from the winter, they frequently walk about until a suitable location is found, after which they assume a culicine-like posture with the body close to the surface upon which they are resting.

Female *freeborni* are active in shelters in Utah and southern Idaho until about the middle of November or first part of December. They then remain in semi-hibernation from this date until about the middle of April when they leave the over-wintering shelters along the foothills and return to breeding areas during the first part of May. Most of them perish in winter quarters where temperatures are below freezing and humidity is high. The first generation of adults appears in early June. The breeding season extends from the middle of May until the first part of October with a gradual increase in numbers until the peak in the adult population is reached during the first part of September. No mid-season slump in the larval or adult population has been observed in this area where larvae develop in nearly all types of mosquito breeding habitats where the water is fresh, cool and sufficiently shaded by emergent vegetation or floatage.

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MOSQUITO SURVEYS AND INSPECTIONS IN THE DISTRICT OF COLUMBIA AREA *

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Mosquito control has been carried on since 1930 in the District of Columbia on a cooperative basis between the U. S. Public Health Service, the D. C. Health and Sewer Department, and the National Capitol Park Service. In 1942 a regular Malaria Control in War Areas program was inaugurated jointly by the U. S. Public Health Service and the D. C. Health Department. Under this program mosquito breeding surveys and regular inspections were made by the entomologist and inspectors, and *Anopheles* control was carried out by labor crews working under the direction of the sanitary engineer in charge. The District of Columbia was divided into ten zones which were in turn divided into an average of 20 subzones each. Each subzone comprised a fairly homogeneous area averaging somewhat over 200 acres. In order to provide a visual ready-reference guide to the problems and progress of the work an extensive map-pin system was used. Streams, ponds, and other breeding places were plotted and given individual numbers, and natural resting places and light trap locations were indicated. Colored pins were used to indicate the species, stage and abundance of *Anopheles* and other mosquitoes in each locality, and the type and progress of control work. All information was brought up to date weekly.

The District of Columbia covers only 69 square miles, varies in elevation from sea level to 420 feet, and is occupied in large part by built-up portions of the city of Washington. The most extensive areas still remaining in their natural condition are under the jurisdiction of the National Capitol Park Service and comprise a large percentage of the lands bordering Rock Creek and the Potomac and Anacostia Rivers. Most of the unimproved land along both rivers is flat and swampy, and provides favorable breeding places for *Aedes vexans* and other mosquitoes.

Special mosquito problems in the District of Columbia during the 1942–1945 period were the following. Street catch basins, of which there are 16,000 in Washington, provided favorable breeding places for *Culex pipiens* and to a lesser extent for *C. restuans.* These proved to be the largest single mosquito control problem although very little inspection was required. Control was by regular oiling by the D. C. Sewer Department. Ornamental pools or lily ponds were second in numbers, it being estimated that there were about 1,000 private ornamental pools in the city. The majority were kept clean and stocked with goldfish but about one out of five was found to contain numerous *Culex* or *Anopheles punctipennis* larvae. *A. quadrimaculatus* was found only rarely in small, private pools but was quite common in larger public ornamental ponds in some of the parks and government reservations. Water chestnut, *Trapa natans,* growing in the bay at the mouth of Oxon Run on the Potomac River in the extreme southern corner of the District provided a favorable breeding place for *A. quadrimaculatus* until it was eliminated by cutting in 1943 and subsequent hand pulling in 1944. The breaking of the banks of the old C. & O. canal during the floods of October, 1942, provided a series of shallow ponds in the canal bed in which *A. quadrimaculatus* and other species bred during the summer of 1943. This condition was easily controlled by oiling until the repairing of the banks eliminated the condition. The usual number of ponds on vacant lots and

* Abstract of an informal talk given Nov. 20, 1945, at the meeting of the American Mosquito Control Association, Silver Springs, Md.

similar locations provided breeding places for all types of mosquitoes. Each of these was dealt with according to the individual problem presented. After the release of the MCWA labor crews in July, 1944, the elimination of standing water on private property has been dealt with as the responsibility of the individual owner and enforced by the legal powers of the Health Department's Bureau of Sanitation. In the District of Columbia the Potomac and Anacostia Rivers, although containing fresh water, are tidal, having a fluctuation of several feet, and offer no breeding places for mosquitoes except in densely matted growths such as that of water chestnut. Creeks were of moderate importance at all times as breeding places for *A. punctipennis* and *Culex* spp., but especially so in prolonged dry periods when the smaller ones dried up into a series of stagnant pools.

The mosquitoes of the District of Columbia were quite extensively collected, particularly by members of the staff of the U. S. Bureau of Entomology, during the years 1893 to 1915. During that time 32 species were taken. No additional species were found after 1914 until MCWA collections during 1942–1945 contained specimens of *Aedes cinereus, Aedes mitchellae, Anopheles barberi, Culex erraticus,* and *Culiseta melanura,* thus raising the total number of species collected to date to 37. All except four of the original 32 species were retaken during this period, one of these being *Aedes aegypti* for which there are no authentic District of Columbia records since 1908. The most abundant species in the District are *Culex pipiens, Aedes vexans, Culex restuans,* and *Anopheles punctipennis. Aedes canadensis* are very numerous in the spring, larvae being taken as early as February 27, but disappear in June. *Psorophora confinnis* and *P. ferox* occasionally become numerous and annoying after floods or heavy rains. Adult female salt marsh mosquitoes, *Aedes sollicitans* and *A. taeniorhynchus* are fairly common at times during the summer, apparently flying in from the Chesapeake Bay area 25 or more miles distant. *Anopheles quadrimaculatus,* toward the control of which most of our efforts have been directed, have been found in each of the ten zones of the District of Columbia, breeding starting about June 1 and reaching a peak around the last week of August. In only a few cases has this species been found in other than small numbers.

A LIST OF THE MOSQUITOES OF PENNSYLVANIA WITH NOTES ON THEIR DISTRIBUTION AND ABUNDANCE [1]

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Malaria Control in War Areas, U. S. Public Health Service

The earliest records of mosquitoes from Pennsylvania are apparently those of Thomas Say (1) who in 1823 stated that *Culex damnosus* (*Aedes teniorhynchus* Wiedemann) and *Culex triseriatus* (*Aedes triseriatus* [Say]) inhabited Pennsylvania. Howard and Marlatt (2) listed three species of mosquitoes from Pennsylvania including new records of *Anopheles punctipennis* Say and *Culex posticatus* Wiedemann (*Psorophora ferox* [Humboldt]). Howard (3) added a new record of *Culex pungens* Wiedemann, which obviously refers, at least in part, to *Culex pipiens Linneaus*. Giles (4) gave four species as occurring in Pennsylvania of which *Anopheles crucians* Wiedemann and *A. quadrimaculatus* Say were previously unrecorded. Howard (5), in addition to the species listed in his previous paper, stated that *Psorophora ciliata* (Fabricius) "is known to occur in Pennsylvania."

Howard, Dyar, and Knab (6) reported eight species of mosquitoes from Pennsylvania including five new state records. These were *Culex territans* (*C. apicalis* Adams), *C. restuans* Theobald, *C. salinarius* Coquillett, *Aedes atropalpus* Coquillett and *A. canadensis* Theobald. Dyar (7) added new records of *Aedes dorsalis* (Meigen) and *A. sollicitans* (Walker), and later (8) he added a record of *Anopheles barberi* Coquillett. More recently Stabler (9) published a list of 17 species of mosquitoes which he had taken by means of light trap and biting collections in Delaware County, Pennsylvania. This list included eight species that were previously unrecorded and made a total of 24 species known from the state.

In the present paper we are listing 34 species of mosquitoes now known to occur in Pennsylvania. This list includes new records of all the previously reported species except *Aedes atropalpus* and *A. dorsalis*. It also includes ten species which are here reported for the first time from Pennsylvania. In addition to this State list we are including a considerable number of new locality records for most of the species as well as notes on the abundance of the various species in different sections of the state.

The data herein presented are based on four years of mosquito survey work performed in Pennsylvania by Malaria Control in War Areas personnel. This work was initiated during the summer of 1942 when an extensive survey was made in Philadelphia and adjacent areas of Delaware County under the supervision of Major Russell W. Gies, USPHS. Surveys at Butler and Phoenixville were performed by Capt. Roy F. Fritz, USPHS, in August, 1943. Since that time the writers have made additional collections in the above-mentioned areas and have carried out surveys in 17 other localities.

Although our work has been primarily concerned with determining the anopheline mosquito populations in the vicinities of Army and Navy establishments, we have also collected and identified most of the culicine species which were encountered. In addition to our regular surveys, a number of miscellaneous collections have been made in various sections of the State as the opportunities afforded. Altogether, we have made collections in 37 localities in 23 of the 67 counties in Pennsylvania. Counties in which collections have been made are: Allegheny,

[1] We wish to express our appreciation to Major Russell W. Gies for furnishing us with many collection records for Delaware and Philadelphia Counties and to Dr. Robert M. Stabler for permitting us to study specimens collected in Delaware County. We are indebted to Mrs. Miriam Boyers Horn and Miss Mary Louise Fagley for performing much of the identification work and for assisting in the compilation of data.

Bucks, Butler, Chester, Cumberland, Dauphin, Delaware, Erie, Forest, Franklin, Huntingdon, Lancaster, Lawrence, Lebanon, Lehigh, McKean, Mercer, Monroe, Philadelphia, Pike, Potter, Warren, and York. In addition to these collections, we are including some records of the Delaware County Mosquito Commission which were furnished us through the kindness of Dr. R. M. Stabler.

The species of mosquitoes now known from Pennsylvania are given in alphabetical order in the following list. The records are those of Malaria Control in War Areas collections except when otherwise indicated. Species not previously reported from the State are preceded by an asterisk. Under each species we have included the localities where it has been taken, the type or types of collections, its abundance, and the earliest and latest months during which it was collected. The name of the nearest town or city that can be located on an ordinary road map is used to indicate the locality.

Symbols are used to indicate the type of collections as follows: (B)—biting; (L)—larval; (N)—sweeping vegetation with an insect net; (R)—adults reared from larvae or pupae; (S)—diurnal resting station; and (T)—light trap. Density ratings are based on the maximum number of specimens taken in the locality in a single collection. A species is generally considered to be rare in a given locality at a given time if no more than nine specimens were found in any one collection; it is considered to be common if from 10 to 99 specimens were taken in one collection; and abundant if 100 or more were taken in a single collection. For some of the rarer species the exact number of specimens, as well as the specific dates of collection are given. General statements relative to the abundance of species in the State are based on more than three years' experience in collecting mosquitoes in this and neighboring States.

In addition to the species included in the following list, three species which we have taken in neighboring states should be listed as of probable occurrence in Pennsylvania. These species are: *Aedes aurifer* (Coquillett), *Anopheles occidentalis* Dyar and Knab, and *Wyeomyia smithii* (Coquillett).

Aedes atropalpus (Coquillett)

This species breeds in rock holes along streams and other bodies of water. We have not taken any specimens in Pennsylvania but it was reported from Shenk's Ferry (Lancaster County) by Howard, Dyar and Knab (6).

Aedes canadensis (Theobald)

This is a common mosquito in Northeastern United States and is usually the first species found in early spring. It occurs in diminishing numbers throughout the summer.

Allentown, (B), rare, July. Buckingham, (L), common, May. Butler, (B), common, June. Galeton, (B), common, August. Glen Mills (9). Kane, (B,L), common, July. Phoenixville, (S), rare, May–June. Sheffield, (B,L), rare, July. Shenk's Ferry, (Lancaster County) Oct. (6). Tobyhanna, (B), rare, July. West Middlesex, (B), common, July.

Aedes cantator (Coquillett)

A. cantator is common along the North Atlantic Coast where it breeds in the brackish coastal marshes. It is a fairly troublesome pest in the southeastern part of the State.

Glen Mills, (B,L,T), common, July (9, in part). Phoenixville, (T), rare, June–Aug. (Identification verified by male genitalia). Ridley Park, (T), rare, June. Swarthmore, (S), rare, June.

**Aedes cinereus* Meigen

This small brown Aedes has been taken in very small numbers from only four localities in the State. It is a common pest in the more northern states where it breeds principally in woodland pools.

Chester, 1 female, Aug. 12, 1945, R. M. Stabler. Hawley, (B), 1 female, Aug. 1, 1945. Norwood, 2 females, Aug. 12, 29, 1945, R. M. Stabler. West Middlesex, (B), 1 female, July 18, 1945.

Aedes dorsalis (Meigen)

This species is generally rare in the Eastern States. We have not taken it in Pennsylvania but it has been reported from Philadelphia by Dyar (7).

**Aedes excrucians* (Walker)

A. excrucians is apparently much less common in Pennsylvania than in the more northern States. It is difficult to separate the females of this species from those of *A. fitchii* and *A. stimulans* and these records should be regarded as tentative. Its occurrence in Pennsylvania seems probable, however, since it is known from New York and New Jersey. We have only four specimens, all females, which were taken in a biting collection in a wooded area near West Middlesex, July 18, 1945.

**Aedes fitchii* (Felt and Young)

We have four females from Buckingham which appear to be this species. These specimens were collected by sweeping vegetation with an insect net on May 18, 1945.

Aedes sollicitans (Walker)

This is the famous "Jersey" mosquito which is abundant along the Atlantic and Gulf Coasts from Maine to Texas. It is a fierce biter and a strong flyer, often travelling many miles from its breeding areas in the coastal marshes. It has also been found occasionally to breed in inland areas in saline waters from salt wells, oil wells, etc. (10). It is a serious pest in the southeastern part of Pennsylvania but has not been taken elsewhere in the State.

Chester, (T), common, June. Darby, (T), common, June–September. Glen Mills (9). Norwood, (T), common, June–August. Philadelphia, (L,T), common, June–September. Philadelphia Neck (7). Ridley Park, (L,T), rare, June–September.

**Aedes sticticus* (Meigen)

A. strictus is a floodwater species which is distributed over the entire eastern United States. We have observed it in tremendous numbers in neighboring states where at times it renders life almost unendurable. Under favorable conditions, it undoubtedly occurs more abundantly in Pennsylvania than our collections so far indicate. We have collected only one male and eight females from four localities in the state. We have also received two females from Dr. R. M. Stabler which were taken in a biting collection along with great numbers of *A. trivittatus* in Delaware County.

Buckingham, (N), 1 male (verified by genitalia) and 1 female, May 18, 1945. Butler, (B), 1 female, June 21, 1944. Delaware County, (B), 2 females, Aug. 4, 1945, R. M. Stabler. Greenville, (B,S), 5 females, June 22, 1944. West Middlesex, (B), 1 female, July 18, 1945.

**Aedes stimulans* (Walker)

This is one of the most annoying of the woodland mosquitoes of the Northeastern States in spring and early summer. It is probably common throughout much of the State.

Buckingham, (N), common, May. Greenville, (B,S), common, June. Philadelphia, (T), 2 females, July 12, 1942. West Middlesex, (B), 3 females, July 18, 1945.

Aedes taeniorhynchus (Wiedemann)

This small salt-marsh mosquito is a severe pest along the South Atlantic Coast, but it is not sufficiently abundant in this State to be of much importance. It is known only from the southeastern area.

Glen Mills (9). Philadelphia, (T), 2 females, July 21, 1942; 2 females, August 21, 1942; 2 females, September 16, 1942.

Aedes triseriatus (Say)

This species breeds in tree holes and is a severe and persistent biter. It has been taken in widely scattered localities though

it has not been found in very great numbers.

Allentown, (B), 6 females, July 21, 1945. Butler, (B), 5 females, June 21, 1944. Delaware County (2). Galeton, (B), 4 females, Aug. 2, 1945. Greenville, (B), 1 female, June 30, 1944. Philadelphia, (T), 2 females, Sept. 8, 1942. Phoenixville, (T), 1 female, July 3, 1944.

Aedes trivittatus (Coquillett)

A. trivittatus breeds in temporary pools and sometimes becomes a severe pest after periods of heavy rainfall. On one occasion we encountered this species in great numbers near Allentown. They proved to be severe biters when their shaded retreat was invaded, but would not follow us out into the bright sunshine as we departed. A temporary pool nearby was dipped as carefully as the thousands of biting pests would permit, but only three larvae of *A. trivittatus* were obtained. They were taken in association with a few larvae of *A. vexans* and *Anopheles punctipennis*. Dr. Stabler informs us that he has also taken this species in great numbers in Delaware County.

Allentown, (B,L,N,R), abundant, July–August. Buckingham, (L,R), 2, May 18, 1945. Delaware County, (B), abundant, August 4, R. M. Stabler. Galeton, (L), 1, Aug. 2, 1945. Glen Mills (7). Greenville, (B), 5 females, June 22, 1944. Kane, (B), 1 female, July 18, 1945. Philadelphia, (T), 1 female, Sept. 1, 1942.

Aedes vexans (Meigen)

This is the most severe and widespread pest among the *Aedes* mosquitoes of this area. The larvae have been most frequently found in temporary roadside and meadow pools.

Allentown, (B,L,N,R), common, August. Buckingham, (L,N), abundant, May. Chester, (L,T), common, June–September. Darby, (L,T), abundant, June–September). Glen Mills (9). Greenville, (B,S), abundant, June. Kane, (L), rare, July. Lancaster, (L), rare, July. Marienville, (L), rare, July. Middletown, (B), rare, May. Northeast, (B), rare, June. Norwood, (T), abundant, June–September. Philadelphia, (L,T), abundant, June–September. Phoenixville, (S,T), common, June–September. Ridley Park, (L,T), common, June–September. Swarthmore, (S), rare, June.

Anopheles barberi Coquillett

This small anopheline breeds in tree holes. Matheson (11) states that it is probably more abundant than generally recognized. We have records from only two localities in the State. In both cases the specimens were collected from privies.

Butler, (S), 1 male and 1 female, Aug. 27, 1943, Roy F. Fritz. Pine Grove Furnace, (S), 1 male, Aug. 11, 1944.

Anopheles crucians Wiedemann

This species is relatively rare in Pennsylvania. It has been taken only in the southeastern part of the State.

Chester, (T), rare, August–September. Darby, (T), rare, July–September. Norwood, (T), rare, July–September. Philadelphia, (T), common, June–September. Phoenixville, (S,T), rare, June–August. Ridley Park, (T), rare, July–August. Swarthmore, (S), rare, June.

Anopheles punctipennis Say

A. punctipennis is by far the most common anopheline in Pennsylvania. It breeds in a wide variety of situations and has been taken in practically every locality where inspections have been made.

Allentown, (L,R), common, August. Butler, (S), rare, June–August. Carlisle, (L,R,S), common, August. Chambersburg, (L,S), common, June. Chester, (T), rare, June–September. Cochranville, (L,R), rare, July. Danville (6). Darby, (L,T,), rare, June–September. Galeton, (B,L,R,S,), common, August. Glen Mills (9). Greenville, (L,S,), common, June–August. Huntingdon, (L,R), common, July. Indiantown Gap, (S), rare, June. Lancaster, (L,R), common, July. Marienville, (L,R), rare, July. Middletown, (S), rare, July. Mount Gretna (12). New Castle, (L,R,S), rare, July. Norwood, (T), rare, June–September. Phila-

delphia, (L,R,T), rare June–September. Phoenixville, (L,R,S,T), common, June–September. Pine Grove Furnace, (L,S), rare, August–October. Pittsburgh, (L,S), rare, July. Ridley Park, (T), rare, June–September. Sharpsville, (S), rare, September. Swarthmore, (L,S,), rare, June. Tionesta, (S), rare, September, L. E. Perry. West Chester, (L,R), rare, May. West Fairview (6). West Middlesex, (S), rare, July.

Anopheles quadrimaculatus Say

This is the common malaria mosquito of eastern United States. It was first reported in the State by Giles (4) who stated that it occurred in "the northwestern part of Pennsylvania." *A. quadrimaculatus* breeds principally in permanent ponds and swamps where the water is warm and well supplied with aquatic vegetation or floating debris. So far, we have not found many suitable breeding areas in the State and accordingly we have seldom taken this mosquito in significant numbers. While it is probable that *A. quadrimaculatus* will breed in quantity in any section of the State where local conditions are favorable (such as we have observed occasionally in the northwestern part of the State), we believe that it is generally much less common here than in the neighboring States of New Jersey and New York.

Chester, (T), rare, August–September. Darby, (T), rare, July–August. Greenville, (L,S), common, June–August. Norwood, (T), rare, August–September. Philadelphia, (L,T), common, June–September. Phoenixville, (S), rare, June–July. Ridley Park, (L,T), rare, September. Sharpsville, (L,R,S,), rare, September. West Fairview (6). West Middlesex, (L,R,S), common, July.

**Anopheles walkeri* Theobald

This anopheline is probably more common in the State than our collections indicate as both larvae and resting adults are usually rather difficult to locate. We have records from only four localities.

Carlisle, (L), 4, Aug. 9, 1945. Galeton, (L), 1, Aug. 2, 1945. Philadelphia, (T), 3 males, 27 females, Sept. 16, 1942. Phoenixville, (T), 1 female, July 3, 1944.

Culex apicalis Adams

This small *Culex* occurs in considerable numbers throughout the State, but since it does not bite man its presence usually goes unnoticed.

Allentown, (L,N,R), rare, August. Butler, (L), rare, June. Chambersburg, (L,S), rare, June. Devon, June (6). Galeton, (L), abundant, August. Glen Mills (9). Greenville, (L,S), rare, June–August. Harrisburg, (S), rare, June. Hawley, (L,R,S), common, August. Huntingdon, (L), rare, July. Lancaster, (L), rare, July. New Castle, (L), abundant, July. New Cumberland, (L,S), rare, July. Norristown, July (6). Philadelphia, (L), common, June. Phoenixville, (L,R,S,T), rare, May–September. Pine Grove Furnace, (L,S), rare, August. Pittsburgh, (L), rare, July–August (6, in part). Pottsville, July (6). Reading, July (6). Ridley Park, (L), rare. Sunbury (6). Swarthmore, (L), common, June. Tobyhanna, (L), rare, July. West Chester, (L,R), rare, May. West Middlesex, (L), rare, July.

**Culex (Melanoconion)* sp. Probably *erraticus* Dyar and Knab

Two specimens of this small dark species were collected in the Philadelphia vicinity by Dr. R. M. Stabler. This is a common southern species which is very rare at this northern limit of its range.

Norwood, 1 female, Aug. 31, 1945, R. M. Stabler. Philadelphia, (Tinicum), 1 female, Sept. 9, 1945, R. M. Stabler.

Culex pipiens Linneaus

The common house mosquito occurs throughout the State, breeding in rain barrels, catch basins, polluted water, etc. It is probably the most important of the pest mosquitoes in Pennsylvania.

Altoona (6). Ardmore (6). Butler, (S), rare, June–August. Buckingham, (L), rare, May. Carlisle, (L,R), abundant, August. Chambersburg, (S), rare,

June. Darby, (L,T), abundant, June–September. Devon (6). Glen Mills (9). Greenville, (S), common, June–August. Harrisburg (6). Hawley, (L,R), rare, August. Indiantown Gap, (S), rare, June. Johnstown (6). Mercer, (S), rare, July. New Cumberland, (L,S), common, July. Norristown (6). Norwood, (T), abundant, June–September. Philadelphia, (L,S,T), abundant, June–September. Phoenixville, (L,R,S,T), common, May–September. Pine Grove Furnace, (S), rare, August. Pittsburgh, (S), rare, July. Pottsville (6). Ridley Park, (L,T), common, June–September. Springdale (6). Sunbury (6). Tobyhanna, (L), rare, July. Williamsport (6). York (6).

Culex restuans Theobald

C. restuans is very similar in appearance to the ordinary house mosquito, *C. pipiens,* except for the characteristic white dots which usually occur on the mesonotum. In many cases it has not been possible to separate the females of these two species with certainty. It seems probable, however, from the data at hand, that *C. restuans* is not uncommon in most sections of the State.

Buckingham, (L), rare, May. Butler, (S), rare, June. Carlisle, (L), rare, August. Chambersburg, (S), rare, June. Doylestown, (S), rare, May. Glen Mills (9). Greenville, (L,S), rare, June–August. Hawley, (L,R), common, August. Indiantown Gap, (S), rare, June. New Cumberland, (S), rare, July. Philadelphia, (S), rare, June. Norwood, 1 female, Sept. 13, 1945, R. M. Stabler. Phoenixville, (L,S,T), rare, May–September. Pine Grove Furnace, (S), rare, August. Sheffield, (S), rare, September.

Culex salinarius Coquillett

This mosquito breeds in both brackish and fresh water and seems to be distributed throughout the State.

Allentown, (N), rare, August. Altoona (6). Butler, (S), rare, June. Carlisle, (L,S), common, August. Chambersburg, (S), rare, June. Glen Mills (9). Greenville, (S), common, August. Hawley, (L,R), rare, August. Lancaster, (L), rare, July. New Cumberland, (S), rare, July. Norwood, 1 female, September 13, 1945, R. M. Stabler. Philadelphia, (L,T), rare, June–July. Phoenixville, (L,R,S,T), abundant, June–September. Swarthmore, (L), rare, June. York (6).

Culiseta inornata (Williston)

This large mosquito is rare in Pennsylvania. It is known from only two localities in the State.

Glen Mills, (T), 1 female (9). Philadelphia, (T), 2 females, Sept. 8, 1942; 3 females, Sept. 19, 1942.

**Culiseta melanura* (Coquillett)

We have seen representatives of this species from two places in Delaware County where they were collected by Dr. R. M. Stabler. It is apparently a rare species in this State.

Chester, 4 females, Aug. 14, Sept. 8, Sept. 11, 1945, R. M. Stabler. Norwood, 1 female, Sept. 3, 1945, R. M. Stabler.

**Culiseta morsitans* (Theobald)

C. morsitans is common in the more northern States but appears to be rare in Pennsylvania. We have collected it in only two localities.

Butler, (S), 1 female, June 21, 1944. Tobyhanna, (L), 2, July 6, 1945.

Mansonia perturbans (Walker)

This large mosquito is a fierce biter and a serious pest in many areas in the northeast. So far, we have not found it in very great numbers in this State though it has been taken in small numbers throughout most of the summer in the Philadelphia area.

The breeding habits of this species differ radically from those of other mosquitoes. Breeding takes place in marshes and ponds having a thick growth of aquatic vegetation. The larvae remain below the surface and obtain air by inserting the sharpened tip of their air tube into the stems and roots of plants. The

pupae also have breathing tubes adapted for penetrating the soft tissues of plants, to which they remain attached until ready for transformation into the adult stage.

Chester, (T), rare, June. Darby, (T), rare, June–July. Glen Mills (9). Northeast, (B), 7 females, June 30, 1944. Norwood, (T), rare, June–July. Philadelphia, (T), rare, June–September.

Orthopodomyia signifera (Coquillett)

This rare species breeds in treeholes. So far, it has been taken in only two localities.

Glen Mills, (T), 2 females (9). Philadelphia, (T), 2, Aug. 3, 1942.

Psorophora ciliata (Fabricius)

This is the largest mosquito known from the state and is also one of the most ferocious biters. Our collections have not revealed it to be present in significant numbers and it has been taken only in the southeastern area.

Darby, 1 female, Aug. 23, 1942. Glen Mills (9). Philadelphia, (T), 1 female, July 7, 1942; 2 females, Aug. 14, 1942; 1 female, Sept. 1, 1942.

Psorophora confinnis (Lynch Arribalzaga)

P. confinnis is a severe pest in some of the southern states, but it does not seem to be sufficiently abundant here to be of much importance. It has been taken only in the southeastern part of the State.

Chester, (T), 1 female, Aug. 20, 1942. Darby, (T), 13 females, July 26–Aug. 30, 1942. Glen Mills (9). Norwood, (T), 1 female, June 4, 1942; 1 female, July 21, 1942. Philadelphia, (T), 24 females, July 21–Sept. 11, 1942. Phoenixville, (T), 1 male, 2 females, Aug. 16–Sept. 29, 1944; 3 females, Aug. 24–Sept. 7, 1945. Ridley Park, (T), 1 female, Aug. 20, 1942.

Psorophora ferox (Humboldt)

This white-footed woods mosquito is extremely rare in Pennsylvania.

Allentown, (B), 1 female, July 22, 1945. Montgomery County (2). Philadelphia, (L), 1, 1942.

**Psorophora horrida* (Dyar and Knab)

This species is rare in the Eastern States and has not been previously reported north of Washington, D. C. We have taken a single female in a biting collection in a wooded area near Allentown, August 10, 1945. This specimen has been deposited in the Cornell University collection.

Uranotaenia sapphirina (Osten Sacken)

This small brilliantly colored mosquito was only recently reported from the State. It is probably more common than our records indicate since it is not a pest species and is therefore often overlooked.

Glen Mills (9). Greenville, (L), rare, June. Philadelphia, (T), rare, June–September. West Middlesex, (L), common, July.

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EFFECTIVENESS OF INSECT WIRE SCREENING

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World War II, among many other things, was indirectly responsible for the first change in the shape of mesh in insect wire screening that has occurred in almost 90 years. From 1857, the earliest known date on which insect wire screening was introduced into commercial distribution, right down to 1945, wire screening for windows, doors and porches has always been made in square mesh.

In the early days, the mesh sizes were coarse, 12 x 12 being the most popular size. But, as time went on, it came to be recognized that mosquitoes among all of the flying insects constituted the greatest menace to the health of human beings, with the common house fly a close second in importance. It likewise became progressively apparent that most varieties of mosquitoes could enter a lighted interior at will through 12 x 12 mesh screening and that 14 x 14 mesh was only slightly more satisfactory. Hence, in late years, the trend has been steadily toward 16 x 16 mesh as offering maximum protection against mosquitoes, as well as flies, with only a minimum sacrifice of light and air.

In 1945, when the industry was straining to produce every last possible square foot of wire screening for South Pacific field hospitals, base hospitals, barracks and all rigid frame structures, the armed services, in response to front line appeals for more and more wire screening, initiated a restricted series of tests to determine whether the mesh had to be square. Obviously, if the filler count could be cut down by proportionately increasing the number of warp wires, loom time would be saved because a shuttle passing back and forth only 14 times to the inch would produce finished screening faster than one which had to travel across the loom 16 and 18 times to produce a lineal inch of screening. As a result of those hurried tests, the armed services decided that 18 x 14 mesh wire screening would be acceptable to them as a substitute for 16 x 16 and 18 x 18 mesh. Immediately following that decision, the War Production Board ordered the industry to produce nothing but 18 x 14 mesh wire screening for civilian use.

Without in any way opposing or obstructing the government on those decisions, the industry set about having further and exhaustive tests conducted by independent agencies to learn exactly how "good" 18 x 14 mesh was in comparison with 16 x 16 and 18 x 18 and particularly with 18 x 18.

Contracts were entered into by the Insect Wire Screening Bureau with the

Fig. 1. Section of Department of Entomology mosquito breeding room at the University of Delaware. Laboratory assistant removing *Aedes aegypti* pupae for insect wire cage screening tests.

University of Delaware and the University of Florida to get to the bottom of the matter. At Delaware, the work was carried on under the personal supervision of Dr. L. A. Stearns, Head of the Department of Entomology. At the University of Florida, Dr. S. S. Block, Associate Research Engineer, Engineering and Industrial Experiment Station, did the work in collaboration with Dr. R. A. Morgen, Assistant Director of the Station, and Dr. J. T. Creighton, Head Professor of Entomology.

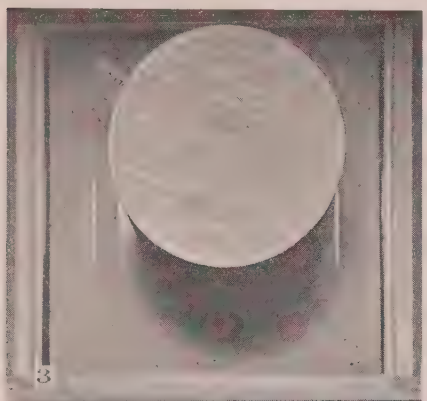
Historical

There are but few references in literature giving what might be termed a quantitative comparison of the effectiveness of different sizes of mesh in insect wire screening. Rosenau (1), referring to previous experimental work at Vera Cruz, noted that the *Aedes* mosquito could pass through 15 x 15, but not 18 x 18 mesh screening. Boyd (2), found that coarse mesh screening, such as 12 x 12 and 14 x 14, afforded a certain amount of protection against *Anopheline* mosquitoes, as estimated from malaria incidence. Earle (3), in Puerto Rico, observed that standard 16 x 16 mesh screening would afford protection against all insects except the small culicoides. Herms and Gray (4), reported that standard 16 x 16 mesh screening does not exclude many *Aedes* and some *Anopheles* species of mosquitoes. For army requirements, the War Department (5), considered the openings of regular 16 x 16 mesh too large. The standard 18 x 18 mesh screen, however, was said to exclude both malaria-carrying mosquitoes and the smaller insect pests.

Materials and Methods

Adult laboratory-bred mosquitoes were introduced, a single species at a time, and in predetermined numbers and sex, into specially constructed screen cages which, in turn, were placed inside of gauze-covered "escape" containers. At the University of Florida, after 48 hours in the laboratory at 85° F. and ordinary room

FIG. 2. Cylindrical cages of ¼, ½, and 1 cubic foot capacity, for testing efficiency of 16 x 16, 18 x 14, and 18 x 18 mesh bronze and steel insect screening wire. Note base construction to permit attachment of glass dish containing mosquito pupae.



Figs. 3, 4 and 5. Looking down on bottom of box "escape traps," showing insect wire screen "confinement cages," and the numbers of mosquitoes which escaped through each of three mesh types. Fig. 3, 16 x 16 mesh. Fig. 4, 18 x 14 mesh, vertical. Fig. 5, 18 x 18 mesh.

lighting conditions, the mosquitoes were gassed with ethylene dichloride and the numbers in the outside escape cages were counted. At the University of Delaware, the procedure was to leave each test undisturbed until all of the mosquitoes died of starvation, a process which required approximately one week for each test.

Preliminary tests demonstrated that lighting conditions (except direct sunlight, which in a very short time proved to be lethal to caged mosquitoes), age, sex and the density (number of mosquitoes confined) had little or no influence on their ability to escape from any of the wire screening test cages.

The sizes of wire screening used in these tests consisted of 18 x 18, 18 x 14, 16 x 16 and 14 x 14 mesh in bronze and electro galvanized steel; all made with standard .011 wire, or its averaged commercial equivalent.

At the University of Delaware, a total of 7,535 mosquitoes were utilized in the 244 separate tests which were conducted at that location. At the University of Florida, 3,406 mosquitoes were used in a series of 100 tests.

Escapes of Mosquitoes from Wire Screen Cages

Curiously enough, while the number of "escapes" at Delaware varied widely from the results obtained at Florida, the proportion was almost exactly the same at both universities; 35.5 per cent for 18 x 14 mesh and 35.8 per cent for 16 x 16 mesh at Delaware and at Florida, 14.3 per cent for both sizes of mesh. Just why the percentages of escapes should have differed so materially is not clear, but results at both stations established the seemingly incontrovertible fact that 18 x 14 mesh is no poorer, nor is it any better than 16 x 16 mesh—the two types of mesh are definitely on a par, one with the other.

18 x 14 mesh as well as 16 x 16 mesh, did not show up at all well at either university in comparison with 18 x 18; 2.7 per cent (average of 15 tests) at Florida and 3.3 per cent (averaged) at Delaware. Both of these percentages, it is readily seen, indicate the far superior protective effectiveness of 18 x 18 mesh over 18 x 14 and 16 x 16 mesh.

14 x 14 mesh and all other off-count meshes tested at Florida failed to approach 16 x 16 and 18 x 14 in protective efficiency; 55 per cent of the mosquitoes confined in 14 x 14 mesh cages escaped, as compared to 14.3 per cent through 16 x 16 and 18 x 14 mesh.

Summary

18 x 14 mesh is on a par with 16 x 16 mesh.

18 x 14 mesh is not anywhere near as efficient as 18 x 18 mesh.

It makes little or no difference in protective efficiency whether the "long" mesh in 18 x 14 is installed vertically or horizontally.

14 x 14 mesh is nowhere near as efficient as 16 x 16 or 18 x 14 mesh for household protection against mosquitoes. And 18 x 18 mesh is from 5 to 10 and more times as effective as any of the coarser sizes.

No differences were discernible between steel and bronze or copper as either an attractant or a repellent of mosquitoes.

The diagonal measurement of a mesh, square or oblong, is believed to be the determining factor in barring out mosquitoes of any given size. The diagonal measurements of ordinary commercial 18 x 14 and 16 x 16 meshes selected at random by the University of Florida proved to be almost exactly the same (.0723" for 16 x 16 and .0739" for 18 x 14; in theoretically perfect cloth the mesh diagonals would measure .0728" for 16 x 16 and .0751" for 18 x 14).

Will 18 x 14 Mesh be a Permanent Size?

Public acceptance and continued consumer demand for that specific size in preference to 16 x 16 will have an important bearing upon the question of whether 18 x 14 mesh will be retained as a permanent item in the insect wire screening "line." That factor cannot be fully evaluated until after the end of the current buying season.

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BREEDING HABITS OF *ANOPHELES FARAUTI (A. PUNCTULATUS VAR. MOLUCCENSIS)* IN NEW GUINEA *

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The records which follow were taken from field notes and reports of the Sixth Malaria Survey Unit, covering the interval from March, 1943, to May, 1944, which show that larvae of *Anopheles (punctulatus var. moluccensis) farauti* were found in:

1. Slow moving side waters of a swiftly running stream. The water was muddy, heavily shaded and supported much vertical aquatic vegetation.
2. Pools not connected to an adjacent stream. These pools were almost completely choked with vertical vegetation.
3. Pools at the edge of a swamp which contained polluted water, rotten leaves, muddy bottom and supported some fish life including "lung" fish. The pools were sunlit.
4. Lagoons, densely shaded, fresh water.
5. Sunlit edges of fresh water lagoons.
6. Slightly brackish water of a coastal swamp.
7. Side pools of well shaded streams.
8. Sagging depressions, holding water, in tent flies and tarpaulin covers in supply dumps open to direct bright sunlight.
9. Borrow pits left alongside the roads by engineering construction crews, some shaded, others in direct sunlight.
10. Wheel ruts holding muddy water and open to direct sunlight.
11. Slit trenches holding water. These were sunlit for part of the day only.
12. Small roadside puddles where evaporation had reduced the water to a thick "chocolate syrup" consistency and color.
13. Cocoanut shells sunk in ground holding water. These shells were probably filled by water from nearby swamp running into the shells after rains.
14. Fallen cocoanut tree fronds holding water.
15. Edges of mangrove swamp, sunlit and shady, fresh water and brackish.
16. Man-made water holes (i.e.) shallow surface wells.
17. Isolated, clear rain water pools, sunlit, no vegetation and not near a stream.
18. Muddy water pools shaded and sunlit found in and around large supply dumps and construction areas.
19. Water in a large biscuit tin found in an open refuse dump in a large operating base in Dutch New Guinea.
20. Marshes, fresh water and brackish, sunlit and shaded.

Geographical Locations of Larva Collecting Stations:

Port Moresby, Papua New Guinea; Dobodura, Papua New Guinea; Oro Bay, Papua New Guinea; Milne Bay, Papua New Guinea; Goodenoogh Island, Papua New Guinea; Ferguson Island, Papua New Guinea; Hollandia, Dutch New Guinea and the Humboldt Bay-Lake Sentani area around Hollandia.

* The author was the Commanding Officer of this Unit from January, 1943, to January, 1945. During this time the Unit saw active overseas service in Australia, New Guinea and the Philippine Islands.

MALARIA CONTROL IN THE DOMINICAN REPUBLIC

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The Dominican Republic occupies approximately two-thirds of the West Indies island originally called "Hispaniola" by Columbus, following the discovery of America. It is situated between Cuba and Puerto Rico and is the second largest island of the West Indies group. For the most part, the Dominican Republic is high lying, having very little coastal plain. Beginning close to the sea, rolling country gradually gives way to hills and mountains as the interior of the country is approached. The exception to this is the Lake Enriquillo Basin in the southwestern portion, which is 154 feet below sea level at the water surface of the lake. There are three distinct mountain ranges lying in a north-west to south-east plane. The highest peak is approximately 11,000 feet above sea level. Drainage from the area north of the central mountain range empties into the Atlantic Ocean and that from the southern slopes empties into the Caribbean Sea. Generally speaking, drainage is good. Swamps, fresh water lakes and lagoons are few, small in size and scattered.

The mild tropical climate found in the Dominican Republic is much the same as that in the neighboring islands. Likewise, the occurrence of malaria is similar and that disease presents a problem in almost every section of the Republic. It is commonly referred to as the No. 1 public health problem but sufficient data are not available to substantiate this opinion. Nevertheless, its importance from standpoints of public health and economy must be recognized. Malaria is present throughout the country but its prevalence varies considerably between communities.

Rainfall is plentiful in most sections, the exception being in the arid desert country in the south-west and north-west parts, where yearly precipitation ranges from 16 inches to 25 inches. However, the rest of the country receives an abundant supply, some parts boasting a yearly precipitation of over 100 inches. As is typical of the Caribbean region, the rainy season is usually from May to October, the heaviest rains occurring in the spring and fall. Generally, there is a definite relation between rainfall and malaria incidence, the number of cases increasing during the periods of most rainfall.

In most communities, breeding places of malaria vectors are confined to streams but swamps are found in or near a few of the coastal towns. Fresh water lagoons are responsible for breeding in a few areas, the lagoons likely having been formed by geological changes in the earth's surface. In recent years, crop irrigation has become an important problem, irrigated rice fields being the principal source of trouble. An agricultural program to develop irrigation tracts is creating increased numbers of such areas and greatly aggravating the malaria problem. Sufficient legislation is lacking whereby intermittent flooding and other control measures might be required. However, a few towns have ordinances regulating irrigation practice as a means of control of malaria. These ordinances establish a "Zona de protección antipaludica" which is the area lying two kilometers distant from the outer limits of the community. Control measures including intermittent flooding, limited storage periods for irrigation water and suitable drainage arrangements are prescribed for fields within the protected zone. The Síndico Municipal is responsible for issuance of permits and is also charged with the enforcement of the ordinance. The country boasts a health service of 26 years. However, the division of malaria in that department was

not established until 1941. Since that time, small appropriations have provided limited facilities for permanent and temporary control measures and a partially equipped laboratory for handling blood and entomological specimens. Activities of the Division have been restricted to a very small radius as a result of limited funds, lack of sufficient personnel and transportation difficulties. Permanent drainage construction by the Division has been undertaken in one community and in that instance is credited with having effected a very wholesome reduction in the malaria rate.

Through the facilities of the health division known as the "Campana Sanitaria" anti-malarial drugs are dispensed throughout the Republic to clinically diagnosed cases. Most of the drugs are used for curative purposes and not for prophylaxis. The cost of the drugs to the Department is considerable and even then it is claimed that the needs have been greater than the supply. Doubtless, the use of anti-malarial drugs has tended to suppress the incidence of the disease, and furthermore has probably interfered with case finding by blood surveys.

In August, 1943, the Institute of Inter-American Affairs, through its Executive Vice-President, Major General George C. Dunham, executed an agreement with the Dominican Republic whereby a cooperative health program was to be undertaken under the sponsorship of the two governments. Accordingly, an allotment of funds was made available by the Institute of Inter-American Affairs which was supplemented by a contribution by the Dominican Government. The cooperative health organization created thereafter is known as the "Servicio Cooperativo Interamericano de Salud Pública." For the sake of brevity, that agency is commonly referred to as the Servicio, which name will be used throughout the rest of this paper. A subsequent agreement between the two governments was executed in February, 1944, and made available additional funds from both governments, thereby expanding the program and extending the period of operation. The Dominican Republic is one of 18 Latin American countries in which this type of cooperative service is being operated. The new schedule calls for operation through the year 1947. Health projects are being formulated accordingly. Though the Second Basic Agreement stated that the Servicio funds might be used principally for malaria control purposes, it did not prohibit the operation of other types of health projects.

Servicio Drainage Projects

Malaria control drainage projects have already been undertaken in three communities in the republic. The three communities are San Cristobal, population about 5,000; Villa Duarte, section of Ciudad Trujillo, population about 10,000; and Monsenor Nouel, population about 4,000. Each project is briefly described below.

The Malaria Division of the National Health Department with the assistance of technicians from the Pan-American Sanitary Bureau provided paved drainage channels for several small streams in San Cristobal. The work was begun in May, 1941, and continued until December, 1943. Approximately 1,900 meters of channel were constructed using small crews of laborers. Panama-type inverts with masonry side walls formed the type of construction. Beginning December 16, 1943, the Servicio continued the work started by the Malaria Division and constructed 2,018 meters of paved channel in extending the paved drainage system. Of that distance, 1,080 meters of distance was paved with pre-cast inverts and masonry side walls. The remaining distance was paved with pre-cast inverts and slabs. Slab dimensions are approximately 14″ x 30″ x 2″ with male and female joints.

The total cost of that project was $15,498.97, not including certain services and equipment which were made available by the Dominican Government. It is thought that the following unit cost will be of interest:

	Unit cost
Excavation, M^3	$0.48
Fill, M^3	0.50
Masonry, M^3	10.50
Inverts manufactured	0.47
Inverts placed	0.26
Slabs manufactured	0.17
Slabs placed	0.10
Cost per meter	7.69
Cost per man-day	0.71

The following quantities of work represent the accomplishments under that project:

Length in meters	2018.3
Excavation, M^3	3802.3
Fill, M^3	414.1
Masonry, M^3	540.5
Inverts	2955
Slabs	8073

As all minor drainage work needed in San Cristobal was not included in the project described above, a supplementary project was undertaken during September, 1944, for the purposes of completing the permanent drainage improvements. This work was completed in March, 1945. Pre-cast inverts and slabs were used in the paving of the channels. The total distance of additional paved drainage is approximately 1,100 meters. An open earth channel, 400 meters in length, was also constructed. The anopheles breeding places now remaining are restricted to a flat river with a gravel bed which changes its course frequently, thereby precluding the possibility of permanent control measures. It is proposed to combat this seasonal problem with the use of larvicides.

Permanent drainage construction was started in Villa Duarte, a section of Ciudad Trujillo, in August, 1944, the project being brought to completion early in April, 1945. Four different areas were included in the Villa Duarte project, which involve both channel construction and filling of low areas. In one flat area along the east bank of the harbor of Trujillo, one large lagoon and several smaller pools were eliminated by grading the sandy river bank between the water's edge and a steep bluff about 100 to 200 meters distant. Approximately 5,000 cubic meters of earth was moved in that operation, all of which was done with the use of wheelbarrows.

The second area, also adjacent to the harbor, involved filling a swampy area with 2,400 meters of filling material and the construction of a channel approximately 525 meters in length.

The third area was quite similar to the second but larger, requiring more than 8,000 cubic meters of filling material. The total length of paved channel is approximately 400 meters.

Work in the fourth area consists of placing pre-cast inverts along highway ditches for improving roadside drainage. The total distance of such drains is 440 meters. These drains were placed largely for demonstration purposes in order to show officials of Public Works Department how inverts may be used along streets and roads where no curve and gutter is provided. The estimated cost of the entire project is $18,280.00. Unit costs involved in the first two areas were as follows:

	Area No. 1	Area No. 2
Excavation, M^3	$0.113	$0.55
Filling, M^3	0.21	0.45
Cost per invert manufactured	....	0.65
Cost per invert installed	....	0.14
Cost per slab manufactured	....	0.21
Cost per slab installed	....	0.06
Rubble Masonry M^3		9.55
Cost per linear meter of completed ditch		7.55

The third town in which drainage improvements have been undertaken is Monsenor Nouel, the estimated cost of the project in that community being approximately $32,000.00. The work which has just been started, will involve the construction of 5,876 meters of paved channel. The malaria incidence in Monsenor Nouel is very high, the number of cases increasing considerably each year during the rainy season. In November, 1944, a blood and spleen survey was made, in which 38 per cent of the smears were positive and 17½ per cent of the spleens indicated malaria.

In addition to the drainage work being undertaken, another condition exists which greatly aggravates the malaria problem. It is due to the shifting of the course of the Yuna River, resulting in the flooding of a large area adjacent to the town by a portion of the river's flow passing through a relief channel which has insufficient cross-section and insufficient drainage structures to carry the flow. The Department of Public Works has been requested to construct a retaining wall or dam sufficient to restrain the river within its normal course.

It has been customary to establish shops for precasting inverts and slabs in the town in which drainage construction is under way. In selecting a site for the shop, an attempt is made to satisfy office and warehouse needs at the same location. It is considered more economical to haul cement and other materials to the site of the invert shop than to haul pre-cast sections from one town to another. In most instances sand and gravel is available locally, which means that only cement, tools and forms need to be transported. Both invert and slab forms are portable and can be easily moved from place to place.

Following the completion of permanent drainage projects in a community by the Servicio, maintenance of channels becomes a responsibility of the Division of Malaria. However, Servicio engineers prepare maintenance schedules which are placed in operation after projects are formally turned over to the Malaria Division.

Malaria Investigations

The principal malaria vector in the Dominican Republic is *Anopheles albimanus* and it is found in all sections of the country. Other species which have been collected are *A. grabhamii* and *A. vestitipennis*. *A. grabhamii* is quite common, being found usually in shaded streams. *A. vestitipennis* is less frequently found, but specimens have been collected in swampy places covered by deep shade (identification by Blatman, 1944). In Bulletin 179, National Institute of Health, Komp reports that *A. crucians* also have been found both in the Dominican Republic and Haiti, but he does not show in what year. Technicians of the Malaria Division suspected one recently found specimen as being *A. crucians* but unfortunately definite identification was not made. Obviously, the number of anopheline species present is small, and it may be definitely stated that *A. albimanus* presents the greatest problem from the standpoint of malaria transmission.

Prior to the establishment of the Malaria Division in the National Health Department in 1941, comparatively little study had been made of the malaria problem. There is nothing in the literature to indicate any concerted efforts having been made. During the years 1941 to 1943, laboratory facilities for handling blood smears were made available and several blood surveys were conducted. Entomological surveys were made also but they were mostly confined to sections in which large numbers of clinical cases were occurring. In March, 1944, the Servicio set up a project for handling malaria investigations. Early surveys were supervised by an entomologist of the Institute of Inter-American Affairs, who assisted in training technicians and in the establishment of a system of field and laboratory operations.

Surveys have been made by communities and in each case have included preparation of maps showing general topography, drainage courses, breeding areas, etc.; blood smears and spleen examinations of samples of the population; searches for anopheline larvae; assembling of available malaria morbidity and mortality statistics; and compilation of rainfall and other pertinent data. While the personnel of the survey group fluctuates to some extent it usually consists of two to three medical officers, one engineer, and three or more medical technicians. Frequently, other survey personnel is drawn from the Servicio engineering section for specific tasks. Field visits usually consume one week and the following week is spent in the laboratory on staining and microscopic

examination of slides, examination of entomological specimens, and preparation of maps and reports. In this way each of the personnel has an opportunity to participate in both field and laboratory work. To facilitate laboratory operations, the Servicio has provided a considerable number of laboratory improvements including microscopes, supplies, furniture, fixtures and needed materials. The improvements have greatly increased the capacity for handling specimens and better organization of work has been made possible.

Mosquito traps of the stable-type have been constructed and placed in operation in several communities, regular collections being made in order to determine the anopheline density. Burros are used as bait. Most of the traps are operated four times weekly, but in some places daily collections are made. The traps being used are of the McGoon type, except that instead of having only one central band for the entry of mosquitoes, two band slots have been provided. The openings are located at elevations of one foot and three feet above the trap base.

Complete malaria surveys were made during 1944 in 31 communities. The total number of blood and spleen surveys was 36. Of this group, the percentages of positive blood smears ranged from 0.8 to 38.0, the median being 7 per cent. The percentage positive of all smears collected was 10.1. Spleen surveys by communities indicated rates ranging from 0 to 42.8 per cent, the median being 6 per cent. The percentage of positive spleens found in all examinations was 8.1. All sections of the country are represented in the 31 communities in which surveys were made.

During 1944 a total of 13,546 blood specimens were examined in the laboratory. The number of spleen examinations made in the field was 7,550. The total number of positive blood smears was 1,374, of which 72.8 per cent showed *Plasmodium falciparum,* 17.18 per cent showed *P. vivax,* 4.73 per cent showed *P. malariae* and 5.61 showed mixed strains.

Other Anti-Malarial Measures

A larvicidal project is to be placed in operation soon. The organization, schedule arrangement, and training of personnel will be handled by the Servicio. The plan is for the Servicio to operate a larvicidal program in a community for three months and then turn over operations to the Division of Malaria for continuation. Larvicidal measures will be restricted principally to towns in which permanent control measures have been completed, and in communities in which malaria epidemics occur.

A recently established health education project is to be used to inform the public in regard to the mode of transmission of malaria and possible control measures. Some material has already been released.

Summary and Conclusions

A Public Health program on a nation-wide basis has existed in the Dominican Republic for more than a quarter century, during which time the Department functioned continuously. Just as in many other countries, the Public Health program during many of its early years was general in scope, and specialized services were largely lacking from its organization structure. In more recent years, technical divisions have been created for the purpose of pursuing problems in specialized fields. An example of this is the Malarial Division which was established in the Dominican Health Department in 1941.

During the four years of its existence, that Division has proven its right to a place in the governmental structure. Technicians have been trained and facilities have been established for the purpose of studying and combatting malaria. Early efforts to effect malaria control have already shown results and prospects are bright for program expansion in the future.

The Dominican Government in cooperation with the Institute of Inter-American Affairs have created a cooperative health agency known as the "Servicio

Cooperativo Interamericano de Salud Pública" to which funds have been made available for program operation through 1947. The Servicio has undertaken several malaria control drainage projects and a project for Malaria Investigations. A project for larvicidal control of malaria and another to provide health education facilities will support the control measures now in operation.

The malaria problem in the Dominican Republic is similar to that on other islands in the Caribbean region. The number of species of Anopheles mosquitoes found is small and *A. albimanus* is the principal vector. Entomological studies are included in malaria surveys.

The principal source of breeding is streams, but swamps, lagoons and irrigated fields are also responsible for anopheline production. Malaria is prevalent throughout the island and constitutes one of the most important public health problems. Rates vary considerably from one community to another but no community is entirely free of the disease.

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Servicio Cooperativo Interamericano de Salud Pública.

MAJOR JAMES D. CALDWELL, A.U.S., Sanitary Engineer, was appointed Chief of the Health and Sanitation Field Party, Institute of Inter-American Affairs, in the Dominican Republic in February, 1944. Prior to his present assignment, he served seven months with the Field Party in Panama, transferring to the Dominican Republic in November, 1943.

Major Caldwell graduated from the Alabama Polytechnic Institute with a B.S. in Civil Engineering and from Harvard University with an M.S. in Sanitary Engineering, and also attended Washington and Lee University, Virginia. He served three years as Director of the City Public Health Engineering program in Knoxville, Tennessee. Since October, 1942, he has served in the Sanitary Corps, A.U.S. On March 5, 1943, he reported for duty on assignment with the Division of Health and Sanitation, Institute of Inter-American Affairs.

NOTES ON MALARIA CONTROL IN MANAGUA, NICARAGUA

CLARENCE I. STERLING
Chief Engineer and Assistant Director, Health and Sanitation Division,
Institute of Inter-American Affairs

Managua, capital city of Nicaragua, has a population of 110,000 (1942). Situated in the Tropics, at an elevation of 180 feet above sea level, the city has a hot, humid climate. It is located on the southern shore of Lake Managua, a large intermontane body of fresh water. Along much of the lake front, especially in eastern Managua, a rocky lacustrine terrace defines the shoreline during periods of high water. In direct relationship to the amount of annual rainfall, the lake level has fluctuated as much as twenty feet in the past sixty years. As a result, varying widths of beach are exposed. The overflow from numerous springs along the base of the lake terrace and rain-water collect in natural and man-made depressions in the beach, and these pools, often protected by rank growth of swamp vegetation, form abundant breeding places for the malaria vector, *Anopheles albimanus*.

Past records of the National Sanidad indicate two yearly peaks in malaria incidence in Managua. Closely following the rainy reasons, the first peak occurs in July or early August while the second and higher incidence rate takes place in November and December. Most of the cases during the first seasonal increase are *P. vivax* while during the second period they are *P. falciparum*.

In 1942 the Institute of Inter-American Affairs and the Government of Nicaragua signed a basic agreement by which the Servicio Cooperativo Inter-Americano de Salud Pública was established as the Nicaraguan portion of the hemispheric cooperative health and sanitation program being carried on in 18 Latin American republics.

Immediately, projects were started to provide health centers, hospitals, medical posts, health education, nurse training, water supply, sewerage systems, general sanitation, and temporary and permanent malaria control throughout the country. At Managua, one temporary and three permanent malaria control projects were established. The larviciding with diesel oil was necessary along the lake shore as an emergency measure because in 1942 Managua experienced its most serious malaria epidemic in many years. Also,

FIG. 1. Col. DeBayle, Institute and Servicio Engineers, and newspaper reporters inspecting drainage ditch.
FIG. 2. Diversion ditch taking form.
FIG. 3. One of the 17 drops along "Cauce Oriental."

the danger was heightened by the wartime scarcity of anti-malarial drugs.

Drainage of the exposed beach along the lake was undertaken. This work had been started in 1932 by the International Health Division of the Rockefeller Foundation. Ten years later, in December, 1942, the Servicio Cooperativo Inter-Americano de Salud Público continued this work and by November, 1943, these drainage facilities were completed. The project included the installation of 10,000 feet of 4-inch and 6-inch open-jointed, sub-surface drains which were connected with paved open canals for ground-water drainage. Work also included special structures, e.g., a 4-foot high masonry retaining wall 650 feet long, culverts, paved chutes, small bridges, and masonry inlet boxes.

The western section of Managua was drained ineffectively by a large, open ditch, called the Cauce Occidental, which had been built in 1890. This ditch followed a northwesterly direction skirting the city limits and discharged directly into Lake Managua. It intersected and drained surface run-off from all principal streets. In the fifty years since its construction, the Cauce Occidental had received little maintenance and at many points the channel was obstructed or seriously damaged. The problem was therefore one of restoration. The project included cleaning and regrading of 11,034 lineal feet of channel, construction of 3 rubble-masonry drops for grade reduction, and building two large concrete arch culverts [88 feet long]. Beginning work in March, the project was finished in June, 1943.

Still another malarious region needed attention. During the past 20 years, the city had grown rapidly from 40,000 in 1924 to 55,000 in 1933 to 110,000 in 1942. Principal urban expansion had been toward the south and east. However, continued penetration in this direction was retarded by the serious malaria problem in that sector of town. Malaria surveys conducted in 1932 by the Sanidad and Rockefeller Foundation and repeated in 1942 by the Sanidad and the Institute of Inter-American Affairs showed the prevalence to be consistently higher in the eastern end of the city. Construction of another large ditch, Cauce Oriental, to drain storm waters into the lake from the settled region was begun in November, 1942, and completed in August, 1943. The original design was drawn by Magoon in 1933, modified by Lowe in 1935, and again modified by the Institute of Inter-American Affairs in 1942. The ditch was built 13,800 feet in length, trapezoidal in shape with the longer side at the top. An interesting feature in its construction is the use of 19 massive concrete drops, four to twelve feet in height, along the course of the channel. The hydraulic capacity of the Cauce Oriental is more than 1,000 cubic feet per second

Fig. 4. Terminal spillway and chute.

in the lower portion compared with 500 second feet for the Cauce Occidental.

In December, 1943, a third parasitic index survey was conducted. The following tabulation indicated the results of the three surveys in Managua.

PARASITIC INDEX SURVEYS, MANAGUA, NICARAGUA

Per cent of blood specimens infected

	1931	1942	1943
Barrio de Silva	.....	70.5	10.5
Barrio Larreynaga	74.03	61.0	13.5
Barrio de Estrada y Pescadores	57.03	51.5	14.5
Barrio de la Cruz	59.36	34.2	6.5
Calle Colon	9.38	9.0	7.0
Barrio Trixione	.....	15.5	5.5
Barrio de la Perla	.....	13.0	8.0
Campo Bruce	.....	26.6	2.5

The average reduction from November, 1942, to December, 1943, was 76.4 per cent.

ASSOCIATION NEWS

ANNUAL MEETING, MAY 24 AND 25, 1946

At the close of the meeting of May 24–25, the Association through its members and subscribers is now reaching beyond the continental United States to include administrative, professional, and other personnel concerned with mosquito control and related work in Australia, Belgium, Bermuda, Canada, Canal Zone, Ceylon, China, Colombia, Ecuador, England, France, Haiti, Hawaii, Mexico, Panama, Puerto Rico and Venezuela.

Mosquito News has grown greatly, and four larger and better numbers were published in 1945, while the March, 1946, number is the largest so far published, containing 69 pages of copy, and 15 pages of advertising. In addition to the feature articles, "The News" regularly contains reviews and abstracts and bibliography sections of outstanding importance to mosquito workers, directories, news notes, and editorials of interest to all members of the Association.

Since the November, 1945, Field Trip and inspection, which was reported in detail in the March, 1946, number of Mosquito News by Miss Helen Louise Trembley, the Association has held two important meetings: an Annual Meeting on April 4, 1946, and a paper reading meeting on May 24 and 25, 1946.

Annual Meeting

The 1946 Annual Meeting was held at the Hotel Ambassador in Atlantic City, N. J., at the time of the Annual Meeting of the New Jersey Mosquito Extermination Association. This was a short meeting, and was devoted primarily to reports of committees and officers, and action on business matters before the Association. Inasmuch as the geographic area represented by the Association is so large that travel limitations prevent complete member representation, the conducting of the election of 1946 officers by mail was authorized, and the election so conducted.

Meeting of May 24–25, 1946

A paper reading and discussion, and business meeting was held at the Hotel Pennsylvania, New York. Sessions were held on the morning and afternoon of May 24, and on the morning of May 25. The program of this meeting was designed to provide ample opportunity for discussion, there being few formal papers scheduled, and those being on subjects likely to promote discussion. This plan resulted in a very interesting meeting, which was attended by approximately 75 persons. Many others were prevented from attending by the rail strike which occurred at the same time.

The president's address was presented at the opening of the business session, as follows:

PRESIDENT'S ADDRESS

Every year since the first President of this Association addressed you there has been a report to the membership of growth, of increased recognition and prestige, and a healthy state of practical and technical advancement.

I feel very fortunate today that the wholehearted cooperation and active assistance of so many members has made it possible for me to carry on this tradition. The advancements that have been made come primarily from the unselfish participation in Association affairs by many busy men who have given freely of their time and energies that this organization might prosper and as I turn over the responsibilities of this office to my distinguished successor I feel confident that he is also acquiring the good will and sound backing of as fine a body of men as it has ever been my privilege to work with.

I do not intend to take up your time here with a lengthy recital of Association activities during the past year but I believe that you are entitled to know

what your officers have done in organization affairs since I took office last June 30 in Norfolk.

On September 4 of last year your Executive Committee met at the Lord Baltimore Hotel in Baltimore for routine business and to discuss plans for a winter inspection trip.

On October 31 a Mosquito Control Conference of the South Jersey Counties was called in Camden, N. J., under the joint auspices of the New Jersey Federation of Women's Clubs, the New Jersey Mosquito Extermination Association, and the *Courier-Post* newspapers. Our membership was well represented and as President of your Association I was privileged to join the able and well known speakers on the program. The significance of such a gathering indicates, I believe, the importance which our work has come to occupy in the public mind.

The winter inspection trip which the Association carried out last November 20 and 21 was pronounced most stimulating and successful by all those who participated. The thanks and appreciation of all of us go to Dr. F. C. Bishopp, who consented to act as Chairman of the Arrangements Committee, and to his associates who provided us with a schedule that was faultless in its timing and remarkable for its varied interests. It was a treat that will not soon be forgotten.

On January 11 of this year the Executive Committee again met at the Lord Baltimore Hotel in Baltimore to conduct routine business and consider certain matters for the good of the Association.

On February 17 a meeting of the Committee on Arrangements was called in Fredericksburg, Virginia, to make tentative plans which have developed into this meeting of today.

The Fourth Meeting of the Dispersal Sub Committee of the National Research Council—Insect Control Committee—was held in Washington, D. C., on February 18 and 19 and a large group from the Association, including myself, attended. The lectures and discussions, dealing primarily with DDT and its application, were timely and instructive.

I believe that the majority of those here today were present at our Business Meeting on April 4 in Atlantic City. It had been decided to hold that meeting in conjunction with the New Jersey Mosquito Extermination Association and our thanks go to that body for their cooperation. Approval of that decision seems to be indicated by those in attendance.

The Florida Anti-Mosquito Association held its Seventeenth Annual Meeting in West Palm Beach only a few weeks ago, from April 28 to May 1, and provided a thoroughly instructive and pleasing program of mental and physical entertainment. Several of our members accepted the invitation to attend and as your President I was asked to address the gathering on behalf of your Association.

Today's meeting completes a year of my tenure of office which has been a period of feverish activity throughout the world and has seen truly remarkable changes take place. Many war time restrictions militated against your Association during this period but I believe that you will agree with me that it has weathered the storm and has emerged even stronger than before. Our active and associate membership has now grown in excess of 250 and our official publication, THE MOSQUITO NEWS, has been developed into a well balanced magazine which in appearance and contents compares most favorably with any similar periodical. It is a credit to the Association and should be a source of much pride to its Editor whose initiative and resourcefulness when added to tireless labor have produced remarkable results.

Golden opportunity for development lies ahead for our profession and for this Association. I have every confidence that the future holds much that is good for us all if we have the wisdom to seek it. For those of us who are stepping down to let new hands take over the wheel, let me say to you that we pledge our full support and cooperation in the belief that your guidance may well lead us to a record of achievement in this year of 1946.

PERRY W. RUTH
Norfolk, Va.

Mr. Robert L. Vannote, chairman of the Finance Committee, presented the report submitted by the Auditing Committee, as follows:

REPORT OF THE AUDIT COMMITTEE

MR. PERRY W. RUTH, President
American Mosquito Control Association

I have caused an examination to be made of the books and records of the Eastern Association of Mosquito Control Workers from the date of the last examination, namely, November 5, 1942, to March 15, 1944, when the name was changed to the American Mosquito Control Association, and of the last named association from March 16, 1944, to May 15, 1946.

The Receipts and Expenditures as shown by the Cash Book were checked and footed for proper computation and found to be correct. All bills paid during the period under examination were checked for correctness and in each instance were properly approved for payment.

The following is a summary of the receipts and disbursements for the period under examination:

	Receipts	Expenditures
Balance per Cash Book November 5, 1942	$120.20	
November 6, 1942, to December 31, 1942	37.00	
January 1, 1943, to December 31, 1943	916.65	$937.92
January 1, 1944, to March 15, 1944	145.00	1.00
March 16, 1944, to December 31, 1944	1,039.22	850.69
January 1, 1945, to December 31, 1945	1,883.40	1,533.94
January 1, 1946, to May 15, 1946	1,113.71	1,087.35
Balance on hand, May 15, 1946		844.28
	$5,255.18	$5,255.18

The balance on hand as shown above was reconciled to the statement as submitted by the Commonwealth Bank of Metuchen.

The books and records of the association were found to have been kept in a very satisfactory manner. Respectfully submitted,

(Signed) W. H. DILLISTON, *Chairman,*
Auditing Committee.

May 22, 1946.

Dr. Robert D. Glasgow, Editor and Chairman of the Publications Committee, presented a report on the progress of MOSQUITO NEWS, and appealed particularly for news notes about the members of the Association, and the work that they are doing. He also requested that photographs showing work being done or submitted together with descriptive captions.

Mr. Vannote, as chairman, presented a report for the Legislative Committee, indicating that the principal matter claiming attention of this committee is the need for developing support for a Federal Appropriation to insure the continuation of the research on the practical applications of new insecticides for mosquito control by the Bureau of Entomology and Plant Quarantine. This matter may soon come before the Appropriations Committee and at that time the members may be called upon to express their support, in order to aid in assuring the continuation of this work.

Mr. James T. Hart, Jr., Chairman, presented a report of the Special Elections Committee as follows:

REPORT OF ELECTION COMMITTEE

New Brunswick, N. J. May 22, 1946.

This is to certify that the undersigned, serving as a special committee appointed by President Perry W. Ruth, have examined and counted the ballots returned in connection with the election of officers of the American Mosquito Control Association for 1946, and hereby present the following report:

Fifty-three valid ballots were returned, and have been tabulated as follows:

President—H. H. Stage, *53.*
1st Vice-President—Dr. R. D. Glasgow, *50.*
2nd Vice-President—Duke Peters, *49;* Harold Gray, *2;* Duncan Longworth, *1.*
Executive Committee—Dr. L. A. Stearns, *51;* Dr. Geo. S. Comstock, *48;* J. Lyell Clark, *1.*
Editor—Dr. R. D. Glasgow, *52.*
Publications Committee—James T. Hart, Jr., *47;* Dr. Robert Matheson, *52;* Eugene Gerberg, *1.*

Four ballots were sent in by Associate Members, who are not eligible to vote. Accordingly, these were not counted.

No invalid ballots were received. James T. Hart, Jr., was unable to attend the meeting.

Respectfully submitted,
(Signed) GEORGE W. EAGER.
VERNON CONANT.

Attest: (Signed) THOMAS D. MULHERN,
Secretary.

Paper Reading Sessions

Papers read, and a report of the symposium discussions will be published in the September number of MOSQUITO NEWS.

T. D. MULHERN.

NEWS AND NOTES

NEW YORK EXPANDS RESPONSIBILITIES OF MOSQUITO CONTROL COMMISSION. To meet a growing local demand, the Suffolk County Mosquito Extermination Commission through the County Board of Supervisors requested, and the 1946 session of the State Legislature passed an amendment to the mosquito extermination law, such that, as Chapter 388 of the State of New York Laws of 1946, effective April 1, 1946, the law now reads: *"Section 410. Powers and Duties of Commission.* Said commission shall use every means feasible and practicable to suppress mosquitoes, ticks, flies, and other hominoxious arthropods which may require community action for their control, . . ." Incidentally, the Commission requested, and the new law provides that the former name "Suffolk County Mosquito *Extermination* Commission" be changed to read "Suffolk County Mosquito *Control* Commission."

R. D. G.

COMMANDER A. A. WEATHERSBEE has recently been separated from the Navy and has returned to the South Carolina State Health Department. Commander Weathersbee directed mosquito control on many projects at Puerto Rico, Norfolk, Virginia, and Okinawa. R. E. DORER

ELIZABETH CITY COUNTY, VIRGINIA. In December, 1945, the Elizabeth City County, Virginia, Board of Supervisors voted to organize into a mosquito control district. Funds were appropriated and work was started at once. Stewart Gibson and T. A. Sheehan were appointed to serve as commissioners. Dr. I. C. Riggin, Virginia State Health Commissioner, who by law is chairman of all mosquito districts in Virginia, appointed R. E. Dorer to act as his deputy. N. L. Benton was appointed by the commission to act as superinntendent. Headquarters are at Hampton, Virginia. The work to be done will consist of drainage and larvaciding and will continue the work started by the Malaria Control in War Areas program carried on by the Public Health Service. R. E. DORER

R. G. PIRIE, Superintendent of the Fresno (California) Mosquito Abatement District, died suddenly of a heart attack on February 2, 1946. He was 44 years old. He had been Superintendent since December, 1942, succeeding A. V. Preuss, who was inducted into the Army.

H. F. GRAY

ROBERT L. USINGER has been released from Malaria Control duty with the U. S. Public Health Service, and has resumed his work at the University of California as professor of entomology and assistant entomologist in the Agricultural Experiment Station with headquarters on the Berkeley campus. H. F. GRAY

F. H. TAYLOR, F.R.E.S., F.Z.S., Entomologist, University of Sydney, Sydney, Australia, died on December 20, 1945. Mr. Taylor was a member of the American Mosquito Control Association.

T. D. MULHERN

H. ELISHEWITZ. A paragraph from a letter to the Secretary.

TROPICAL OIL COMPANY
BARRANCABERMEJA
COLOMBIA, S. A.

El Centro, Colombia
February 28, 1946

Dear Tommy:

. . . . . .

I've just come back from a 950 mile one-month long trip down the Magdalena river by launch. Stopped in 10 different towns and stations and did anopheline reconnaissances. There are three different and distinct ecological and biological strata represented in the various sections of the river: in the uppermost section, *punctimacula* is the main vector, in the central section, *darlingi*, in the lowest,—a semi-arid region—*albimanus*.

The river represents the nastiest malaria problem of any place that I have encountered. So extensive that engineering control is impossible; such high mosquito populations that 8 to 10 thousand mosquitoes enter each trap each night; and in most sections the malaria rate is 3000 to 5000 cases per 1000 people per year. I had a chance to do some nice biological studies which show that, contrary to published experiences, *An. darlingi* will enter traps to feed on man, horses, mules, cattle, dogs, chickens, pigs, and goats. Also accumulated some data on their quantitative host preferences; their flight times, hours of feeding, and resting habits.

I'm sorry that I won't be able to get to the meetings this year but hope them the best of success.

Sincerely yours,
(Signed) H. ELISHEWITZ.

DR. JOHN M. HUFF, now Director of Public Health, City of Norfolk, Virginia. A letter to the Editor.

Norfolk, Virginia
May 16, 1946

Dear Doctor Glasgow:

I know that you are constantly in search of items of news which have a bearing on the welfare of our Association and of our profession

in its larger sense. I believe that any important change in the prominent personnel of an organization directing mosquito control naturally falls in this classification and I offer a few details of a move that was recently made in the City Government of Norfolk in the hope that both you and the membership may care to have them.

The appointment of Dr. John M. Huff as Director of Public Health for the City of Norfolk should be of interest to the membership not only because a number of us have had the privilege of personal acquaintance with him but also because the man who is to fill this important office has displayed such an active interest in the knowledge of anti-mosquito work.

A former Medical Officer for more than 25 years in the regular Navy, Dr. Huff was called from retirement in 1944 to act as Assistant, with the rank of Commander, to Rear Admiral James J. A. McMullin, then Chief Medical Officer of the Fifth Naval District with Headquarters at the Norfolk Naval Operating Base. The problems in Sanitation and Public Health in this District, under the war time emergency, which he aided in solving so satisfactorily were manifold and gave proof of his technical ability while at the same time the loyalty of his own staff and the friendly relations he established with City Officials and other civilians with whom he came in contact indicated a remarkably pleasant personality.

It was during this period that the potential mosquito hazard in Norfolk created by war time Naval construction assumed its most serious proportions. Admiral McMullin gave the situation his immediate and personal attention with instructions to Commander Huff that remedial action be undertaken at once. Thanks to the latter's administrative ability, an organization was quickly set in motion and under his direction our Albert A. Weathersbee, then a Lt. Commander in the Naval Reserve, undertook extensive field operations which he carried forward with great success until his transfer to the Pacific Theater of War. Our Donald MacCreary, also a Lt. Commander in the Naval Reserve, was then assigned to the Norfolk Operating Base, under Commander Huff, and was instrumental in completing the task which resulted in almost total temporary control and led to the elimination of the major breeding sources.

Throughout this whole period there was the most friendly and complete cooperation between the Naval Medical Department and the Norfolk Bureau of Mosquito Control which was in almost daily contact with Commander Huff. Plans were under way to design a permanent drainage system to eliminate the breeding areas created by Naval construction and Commander Huff was instrumental in bringing our Secretary, Thomas D. Mulhern, to Norfolk to act as an expert consultant in the matter and to submit a report with recommendations to the Naval Medical Department to be considered by them before giving their approval of final plans and specifications. The engineering work on this project has now been largely completed in a very successful manner and will stand in no small way as a tribute to the vision, understanding and executive ability of Dr. Huff.

When Dr. Huff retired from Naval service this Spring with the rank of Captain, it was most natural that he should be considered for the post of Director of the Department of Public Health, newly created by the Norfolk City Council. In spite of a natural desire for a period of rest from the arduous duties he had but lately relinquished, he was persuaded to indicate his willingness to accept the appointment and his name was at once submitted to City Manager H. H. George, 3rd, by the Advisory Commission on Public Health, composed of six well known local physicians, with a very favorable recommendation. Affirmative action was taken at once and Dr. Huff's appointment as Norfolk's first Director of the Department of Public Health was announced on March 6.

Since taking over his duties he has made many new friends among his associates and has indicated a thoroughly cooperative attitude toward the Bureau of Mosquito Control, which now comes under his direction. As Chief of that Bureau I feel that our organization is peculiarly fortunate in the City Manager's selection of a man with the knowledge and interest that Dr. Huff has displayed in mosquito work. Undoubtedly the growth and development it made under the splendid guidance of the Director of Public Welfare may be expected to continue uninterrupted.

Yours very truly,

PERRY W. RUTH,
President.

EDITORIAL SECTION

TO THE MEMBERS OF THE ASSOCIATION

Greetings:

Grateful acknowledgment is made of your confidence in selecting me to serve as President of the American Mosquito Control Association for the coming year. I appreciate the honor and I wish to assure you that energetic steps will be taken to foster the Association's interests.

During the past few years we have seen the Association grow from a sectional group of mosquito control workers to a national organization including members from foreign lands. This expansion of the Association during the war years was aided greatly by the impetus given mosquito control by our military forces. Entomologists and sanitary engineers who had little actual experience in this field found it intriguing and challenging to their profession and their mentality. These men accomplished much; and their efforts in stepping up the efficiency of the military through a reduction of mosquito annoyance and mosquito-borne diseases is well known. Our successful conclusion of the war reflects in part the effective results obtained by the malaria control units throughout the world.

A parting of the ways is at hand, however. There is one pathway leading to an increased interest in mosquito and malaria control in this country and the land adjacent to our air strips around the world. The other pathway may lead to greatly reduced forces in mosquito control activities with an accompanying reduction of personnel.

It seems to me the time is opportune for a greatly increased interest in mosquito control because of the knowledge gained by so many. In other lands doubting Thomases have witnessed effective mosquito control measures in areas presenting more obstacles to the reduction of the mosquito population than we normally encounter in the United States. The need to wipe out the mosquito pest in many resort and agricultural sections, and particularly to banish malaria from the United States by killing *Anopheles quadrimaculatus* mosquitoes, is urgent.

The advent of DDT and its use in a number of ways, especially from aircraft, gives us added assurance that we no longer need tolerate mosquitoes—that is, unless our lethargy wills otherwise.

The need for concerted action is also urgent. Mosquitoes are no respecters of boundaries. We have heard this too long without doing much about it. Adequate legislation to provide for Federal aid to local, State, and country mosquito abatement districts should be enacted.

These are some of the problems that should be the responsibility of an organization such as the American Mosquito Control Association. To meet this responsibility, however, we must grow in numbers and in strength. And that is where every member can give a hand. Enrollment of a new member or an elevation from associate to active membership is within the reach of each of us.

Our entire membership can also assist in building MOSQUITO NEWS by forwarding to the Editor from time to time reports of their work and descriptions of new techniques and new short cuts to more economical and effective work.

Happy days are here again. May all of those responsible for wiping out the mosquito pest dedicate themselves to the task of keeping their districts happily free of mosquitoes.

Sincerely yours,
(Signed) H. H. STAGE,
President.

REVIEWS AND ABSTRACTS

Los Anofelinos de la República del Ecuador. By Roberto Levi Castillo. Vol. I, vi+1–72, Artes Graficos, Senedefelder C. A., Guayaquil, Ecuador.

(This publication was reviewed in an earlier number of Mosquito News by H. H. Stage; but we are delighted to publish a second review which in response to an earlier request was very kindly written by a neighbor of the author, Dr. Arnoldo Gabaldon, M.D., Division of Malariology, Ministerio de Sanidad y Asistencia Social, Salubridad Pública, Maracay-Aragua, Venezuela. Editor.)

The author, a sanitary entomologist, presents data on 11 anopheline species found in Ecuador. In the introductory section he describes the different regions of the republic and gives monthly meteorological data: temperature, relative humidity and rain. The species treated are *Chagasia bathanus; Anopheles pseudopunctipennis, A. eiseni, A. punctimacula, A. apicimacula, A. mediopunctatus, A. albimanus, A. aquasalis, A. neivai* and *A. boliviensis.*

A detailed description for each species is given. The chaetotaxy of the larva is treated, with the exception of hairs of the abdominal segments. The female characteristics and the male terminalia are well described.

Plates corresponding to the description of each species are found at the end of the volume, but some of the drawings have been poorly reproduced, especially those of the larval chaetotaxy. Notes on the ecology and geographic distribution and the section of every one of the anophelines. Five maps and 54 photographs illustrate these points.

Dichotomic keys for eggs, larvae, females and male terminalia are presented at the end of the volume together with a list of species by province. Twelve pages of bibliographical references are also included.

The author includes description of two varieties of *Anopheles pseudopunctipennis* which had previously been published, i.e., *levi-castilloi* Levi-Castillo, 1944, and *rivadeneirai* Levi-Castillo, 1945. From the description and plate the reviewer cannot find differences from the "tippicos" known from other places of the Western hemisphere, with the possible exception of the eggs, which on account of the poor drawings and the normal individual variations found in this species, makes it hard to reach a definite conclusion.

The volume is the most complete information available at the present time on Anophelines from Ecuador. Arnaldo Gabaldon

Lessons in Malariology from World War II. The Charles Franklin Craig Lecture for 1945 by Paul F. Russell, Amer. Jour. of Trop. Med., Vol. 26, No. 1, pp. 5–13, Jan. 1946.—A concise summary of recent advances in malariology including the parasitological, clinical, therapeutic and entomological fields. Reference is made to the repellents developed during the war, to the extensive use of paris green (one pilot alone having distributed a half-million pounds of the mixture in Corsica), to aerosols as adult mosquito killers, to the use of DDT as a residual spray in buildings and in the form of sprays and aerosols out-of-doors. The importance is stressed of proper training and effective organization for the conduct of educational work, surveys, prophylaxis, and mosquito control.

Dr. Russell observes that "The greatest social obstacle to malaria prophylaxis in the world today is the lack of suitable malaria control organizations. Economic barriers have been removed by spray-killing. Rural malaria control in many areas can now be one of the least expensive of public health measures. But until there is wide acceptance of the outstanding lesson about essential organization, so clearly demonstrated again in World War II, malaria will remain a paramount disease." Fred C. Bishopp

Life Cycle of the Mosquito. An excellent new mosquito film, produced by the Emerson Yorke Studio, 35 West 45th Street, New York 19, with acknowledgment for technical collaboration credited to: (a) The United States Public Health Service, Washington, D. C.; (b) The New Jersey State Agricultural Experiment Station, New Brunswick, New Jersey, mentioning Dr. J. B. Schmitt, Research Specialist, by name; and (c) The Rockefeller Foundation International Health Division, New York City. The film is a single reel, with a running time of 12½ minutes. Prints of the film are available in 35 mm. and 16 mm. with sound.

As provision for rotation in order to avoid too frequent repetition in their showing, there is need for several good films of each important scientific and educational subject. Mosquito News, therefore, is happy to welcome this new mosquito film as an important addition to the repertory available to the teacher, to the public relations officer of the mosquito commission, and to the public health official.

This new film exhibits some excellent technique in scientific cinemicography, and in the manipulation of the living mosquitoes which were posed as star performers in its production.

The distinguishing characteristics and behavior of the Anopheline and the Culicine mosquitoes are well known, as are the structure of the mouth parts, and the feeding habits of the adult mosquito.

One female mosquito obligingly proceeds to deposit her eggs under the glaring illumination of the micro-"studio"; another unconcernedly takes a full blood-meal before the camera.

The life cycle is well shown, including the feeding habits of the larvae, transformation into the pupa stage, and final emergence of the adult.

As the title indicates, major emphasis is placed upon the "Life Cycle of the Mosquito." At least for the health officer, therefore, the film might sometimes be shown with advantage in connection with a film or films made with major emphasis upon one or more of the mosquito borne diseases.

This is a film that should be seen by everyone concerned with educational and public relations work in which a knowledge of mosquitoes, of their public health significance, and of their control is logically a part. It is well worthy of a place in any educational film library.

R. D. G.

A microstudio where mosquitoes were star performers in the production of the new film, "Life Cycle of the Mosquito." Emerson Yorke Studio, 35 West 45th Street, New York 19, N. Y.

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